Models for forewarning the incidence of castor semilooper Achaea janata Lin (Noctuidae: Lepidoptera) and its parasitoids

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Models for forewarning the incidence of castor semilooper *Achaea janata* Lin. (Noctuidae: Lepidoptera) and its parasitoids

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ABSTRACT

Analysis of three years data revealed that among different weather variables, rainfall at 7 days lag and evening relative humidity of 6 days lag were found to have significant positive influence, while maximum temperature and vapour pressure deficit at 6 days lag had significant negative influence on semilooper eggs. None of the weather variables were found to have significant correlation with larval population of castor semilooper. Maximum temperature at 3 and 4 weeks lag had significant negative influence, while evening RH during the same period along with vapour pressure deficit at 4 weeks lag and minimum temperature at 1 to 3 weeks lags had significant positive effect on the *Trichogramma* egg parasitisation. Minimum temperature at 3 weeks lag and max temperature and evening RH at 3 and 4 weeks lag had significant positive influence on larval parasitisation by *Snellenius*. The step-wise regression analysis of the three years data resulted in models to predict eggs and larval stages of *A. janata* and their two important natural enemies' 3 to 7 days in advance. The models developed explained 52 and 31 percent of the variability in predicting semilooper eggs and larvae, respectively while, it was 57 and 62 per cent for *Trichogramma* egg parasitoid and *Snellenius* larval parasitoids, respectively.

Key words: Castor semilooper, *Trichogramma*, *Snellenius*, parasitoids, weather, forecasting models

Castor, *Ricinus cummunis* Lin. is one of the important non-edible oil seed crops of India grown in about 8.64 lakh ha with a productivity of 1164 kg ha^{-1} (Damodaram and Hegde, 2007). Among various insect pests that attack castor, semilooper, *Achaea janata* Lin. is an important defoliator. Under severe infestation they completely devour the green foliage, leaving only the veins and enforce the famers to re-sow the crop. It is an endemic pest, reported from all the major castor growing states of the country and causes yield reductions to the extent of 20 to 23 per cent (Gaikwad and Bilapate, 1992; Basappa and Lingappa, 2001). Natural biological control plays a key role in regulating the population dynamics of semilooper under field conditions and the extent of parasitisation by different natural enemies goes up to 43 to 95 per cent (Gaikwad and Bilapate, 1989; Prabhakar and Prasad, 2005b). Though there were few studies on establishing relationships of castor semilooper incidence with certain weather variables (Srinivasa Rao, 2003), the information on models for forewarning their incidence is meager. This study was an attempt to model the incidence of castor semilooper egg and larval population along with its two key natural enemies viz., egg parasitoid, *Trichogramma achaea* (Trichogrammatidae: Hymenoptera) and larval parasitoid, *Snellenius maculipennis* (Szepligeti) (Hymenoptera: Braconidae).

MATERIALS AND METHODS

Field experiments were conducted at the Hayathnagar research farm, CRIDA, Hyderabad (17^0 20' 28" N, 78^0 35' 33" E) during 2001- 2003. Castor cv. DCS-9 was sown in a plot measuring 1000 m^2. The dates of sowings were June 8, June 21 and July 14 during the years 2001, 2002 and 2003, respectively. The entire experimental block was divided into 100 equal quadrates of 10 m^2 each. The observations on eggs and larvae of semilooper were recorded every week from 10 plants selected from three quadrates. The larvae and eggs were collected every week from the unsprayed plants of castor and were brought to the laboratory. Eggs were transferred to individual glass vials and larvae into rearing cages, which were maintained at 27± 1 ^{0}C temperature and 60± 10 per cent relative humidity. Fresh leaves of castor were provided every day as food

Table 1: Correlation coefficients between semilooper egg count and weather variables

Weather variable	Lag days							
	0	1	2	3	4	5	6	7
Max T	0.13	0.08	0.06	0.03	-0.18	-0.27	-0.37**	-0.18
Min T	0.20	0.14	0.21	0.20	0.27	0.26	0.27	0.15
MRH	-0.17	-0.34*	0.01	-0.10	0.04	0.16	0.20	0.18
ERH	-0.13	-0.10	-0.13	-0.10	0.20	0.21	0.39**	0.13
RF	-0.08	-0.01	-0.40	-0.70	-0.08	-0.14	-0.10	0.41**
SSH	0.05	0.21	0.05	0.04	0.25	-0.19	-0.04	-0.14
VPD	0.19	0.16	0.10	0.10	-0.18	-0.22	-0.36*	-0.19

*, ** Significant at 5 and 1 per cent probability

Table 2: Correlation coefficients between semilooper larva and weather variables

Weather variable	Lag Weeks				
	0	1	2	3	4
SSH	-0.07	-0.27	-0.16	0.05	-0.21
Max T	0.21	0.15	0.03	0.13	0.20
Min T	0.21	0.27	0.17	0.07	0.23
MRH	-0.02	0.02	-0.10	-0.13	0.02
ERH	0.04	0.13	0.03	0.02	0.14
VPD	0.05	-0.05	-0.01	-0.01	-0.13

for semilooper larvae. Observations were recorded daily for parasitoid emergence. Per cent parasitisation was worked out for egg and larval stages separately. The data on larval count and per cent parasitisation of egg and larva were subjected to square root transformation before statistical analysis. All the daily weather parameters were recorded from the agromet observatory of HRF Farm, CRIDA. The saturated vapour pressure (SVP) in K Pa at mean temperature T (°C) was calculated following the method of Tetens (1930).

SVP = exp (16.78T-117/T+237.3)

Actual vapour pressure (AVP) was calculated from the SVP and the mean relative humidity

AVP = (SVP*mean RH/100)

Vapour pressure deficit (VPD) = (SVP- AVP)

Egg laying by semilooper was observed only for few days in a season. H... correlations of the weekly egg data was done with daily weather variables of six previous days. Incase of semilooper larvae and their natural enemies, they were found all through the se[ason] though the density and severity was varying. He[nce] correlations were made between weekly larval c[ount] along with its parasites and the mean weather va[riables] of four previous weeks. Along with the mean we[ather] worked out the coefficient of variation and stan[dard] deviation for each weather variable in a week to ca[pture] sudden changes in weather (Victor *et al.*, 2003) these values were regressed upon the pest dat[a] stepwise regression analysis was carried out with weather as dependent variables for semilooper and weekly means, standard deviation and coeffi[cient] of variation of different weather variables semilooper larva, and its parasitoids. The mo[dels] developed were validated for all the three years.

RESULTS AND DISCUSSION

Analysis of four years data (2001-2004) on w[eekly] pest count from the field experiments conducted [at] Hayathnagar research farm and the correspo[nding] weather resulted in establishing pest we[ather] relationships and models that could be used to pr[edict]

Table 3: Correlation coefficients between Trichogramma egg parasite and weather variables

Weather variable	Lag Weeks				
	0	1	2	3	4
SSH	-0.02	-0.17	-0.05	-0.20	-0.26
Max T	0.09	-0.12	-0.24	-0.42**	-0.34*
Min T	0.35*	0.40**	0.31*	0.09	-0.04
MRH	-0.16	-0.07	-0.04	0.16	0.21
ERH	0.00	0.14	0.18	0.33*	0.40**
VPD	0.04	-0.01	-0.05	-0.23	-0.30*

*, ** Significant at 5 and 1 per cent probability

Table 4: Coefficients between *Snellenius* larval parasite and weather variables

Weather variable	Lag Weeks				
	0	1	2	3	4
SSH	-0.02	-0.17	-0.05	-0.20	-0.26
Max T	0.09	-0.12	-0.24	-0.42**	-0.34*
Min T	0.35*	0.40**	0.31*	0.09	-0.04
MRH	-0.16	-0.07	-0.04	0.16	0.21
ERH	0.00	0.14	0.18	0.33*	0.40**
VPD	0.04	-0.01	-0.05	-0.23	-0.30*

different stages (eggs, larva) of *A. janata* and their two important natural enemies' viz., egg parasitoid, *Trichogramma achaea* and larval parasitoid, *Snellenius maculipennis* 3 to 7 days in advance.

Among different weather variables, the evening relative humidity of 6 days lag was found to have significant positive influence, while Max T and vapour pressure deficit at 6 days lag had significant negative influence on semilooper eggs. However, rainfall at 7 days lag and evening RH at 6 days lag had highly significant positive correlation with semilooper eggs (Table 1). All the weather variables showed varied and non significant relationship with the larval population of semilooper (Table 2). Srinivasa Rao (2003) reported that minimum temperature had significant positive influence on semilooper eggs and larvae and maximum temperatures had non significant negative influence on larvae. In this study though the minimum temperature had positive effect on both eggs and larvae, they were statistically non significant. The poor correlations of larval population with the weather variables could be due to the prevalence of high parasitisation of semilooper eggs by *Trichogramma* achaea (up to 86 %) and the semilooper larvae by *Snellenius maculipennis* (up to 95 %) at this location (Prabhakar and Prasad, 2005b). The significant correlations between semilooper population and their two natural enemies (Table 5) suggest that it is important to take into account the natural parasitisation levels for successful prediction of semilooper larval population on castor.

The stepwise regression analysis resulted in separate models for prediction of semilooper eggs and larvae with a coefficient of multiple determinations of 0.52 and 0.31 respectively (Table 6). The validation of these models showed promising results only for semilooper eggs. In case of larvae, the model failed to capture the peak incidences when the population is very high and was over predicting when the larval densities are low (Fig. 1). Hence it could be inferred that more than the weather, the natural parasitisation plays a key role in population dynamics of castor semilooper. Attempts were made to develop models for predicting the incidence of two important natural enemies of castor semilooper viz., egg parasitoid *Trichogramma* sp. and the larval parasitoid, *Snellenius maculipennis.* The correlation of the natural parasitoids with weather variables showed that maximum temperature at 3 and

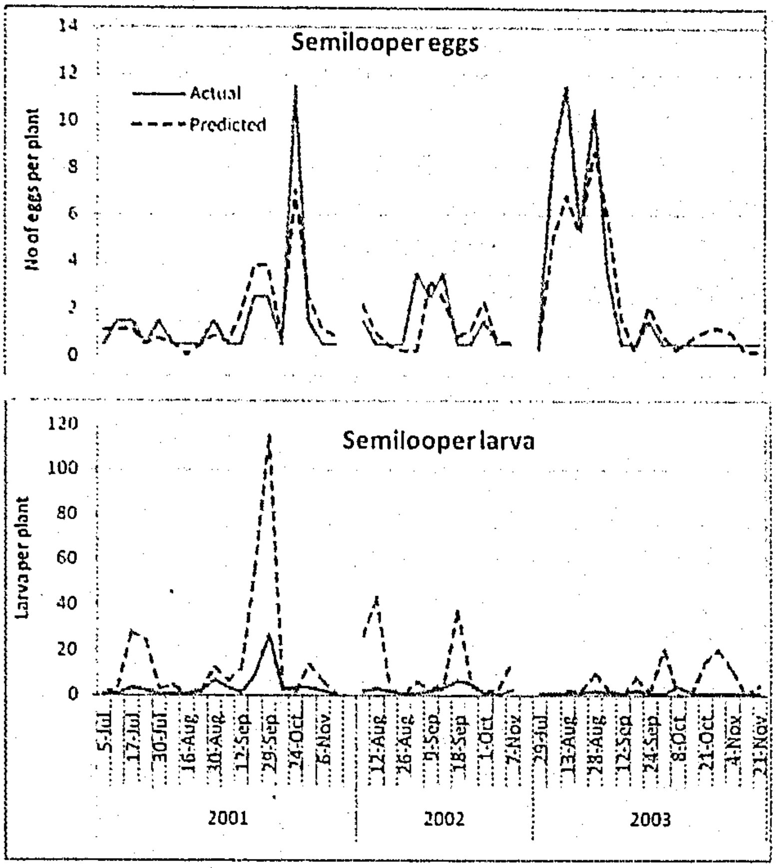

Fig. 1: Validation of forecasting models of castor semilooper eggs and larva

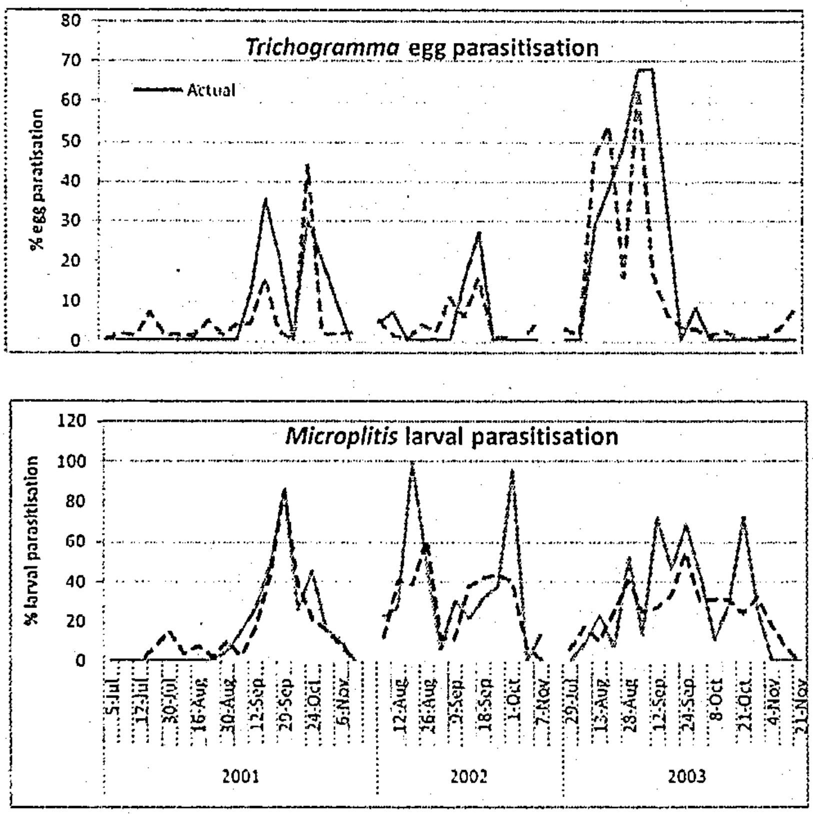

Fig. 2: Validation of forecasting models of parasitoids of castor semilooper

Table 5: Correlation coefficients between semilooper with their natural enemies

	Trichogramma egg parasitoid	*Snellenius* larval parasitoid
Semilooper egg	0.695**	0.024
Semilooper larva	0.146	0.315*

*, ** Significant at 5 and 1 per cent probability

Table 6: Forewarning models for semilooper and their natural enemies:

Stage	Model	R^2	Description of dependent variables
Semilooper egg per plant after three days	$4.6 + 0.121X_1 + 0.443X_2 + 0.71X_3 - 0.69X_4$	0.52	X_1: Total rainfall (mm) of previous 4 days X_2: Sunshine hours of the previous day X_3: Minimum temperature of previous 3 days X_4: Maximum temperature of the previous day
Semilooper larva per plant after one week	$1.37\text{-}10.41\ X_1 + 0.048\ X_2 + 0.14\ X_3$	0.31	X_1: Coefficient of variation of morning RH previous one week X_2 : Total rainfall of previous one week X_3: Standard deviation of morning RH of previous one week
Per cent egg parasitisation by Trichogramma after one week	$2.511 + 0.592\ X_1 - 4.32\ X_2 - 0.67\ X_3 + 1.31\ X_4$	0.57	X_1: Semilooper egg count on 10 plants X_2: Coefficient of variation of VPD of previous two weeks X_3: Standard deviation of maximum temperature of previous one week X_4: Coefficient of variation of sunshine hours previous four weeks
Per cent larval parasitisation by Snellenius after one week	$24.32 - 1.20\ X_1 + 0.63\ X_2 + 0.82\ X_3 - 4.44\ X_4 + 0.123\ X_5$	0.62	X_1: Mean Maximum temperature of previous four weeks X_2: Mean Minimum temperature of previous one week X_3 : Mean sunshine hours of previous four weeks X_4: Mean VPD of previous four weeks X_5: Sum of rainfall during previous three days

4 weeks lag had significant negative influence, while evening RH during the same period along with vapour pressure deficit at 4 weeks lag and minimum temperature at 1 to 3 weeks lags had significant positive effect on the Trichogramma egg parasitisation. Minimum temperature at 3 weeks lag and max temperature and evening RH at 3 and 4 weeks lag had significant positive influence on larval parasitisation by Snellenius. While vapour pressure deficit at four weeks lag had a significant negative influence. The weekly weather data regressed on the parasitisation levels of these two parasitoids resulted in models that explain 57 to 62 per cent of the variability (Table 6). Validation of these models could capture the peak parasitisation levels of both these parasitoids in all the three years of study (Fig. 2).

It is important to conserve the parasitoids by avoiding pesticide spray when their activity is at peak. Hence it is suggested that before running the forewarning model for semilooper pest, it is prudent to run the model for the natural enemies and assess their population levels. If the parasitisation levels are predicted to be more than 50%, there is no need to resort to any pesticide sprays as the natural biological control would keep the pest under check (Prabhakar and Prasad, 2005a). More so, any insecticidal spray at this stage would adversely affect the natural enemy population and may result in sudden out break of the semilooper pest.

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REFERENCES

Basappa, H. and Lingappa, S. 2001. Damage potential of *Achaea janata* Linn. at different phenological stages of castor. *Indian J. Plant Protection*, 29 (1&2): 17-24.

Damodaram, T. and Hegde, D.M. 2007. Oil seeds situation: A statistical compendium, 2007, Directorate of Oil Seeds Research, Hyderabad.

Gaikwad, B.B. and Bilapate, G.G. 1989. Field life tables and key mortality factors of *Achaea janata* Linn on castor. *Proc. Indian Acad. Sci. Animal Sciences*, 98 (5): 331-339.

Gaikwad, B.B. and Bilapate, G.G. 1992. Parasitisation of *Achaea janata* and estimation of losses on castor. *J. Maharastra Agri. Uni.*, 17: 195-196.

Prabhakar, M. and Prasad, Y.G. 2005a. Biolog seasonal dynamics of *Snellenius maculip* (Szepligeti) (Hymenoptera: Braconidae) a parasitoid of castor semilooper, *Achaea* (Lin.) (Lepidoptera: Noctuidae). *J. Biol. Co* 19 (1): 29-34.

Prabhakar, M. and Prasad, Y.G. 2005b. N parasitisation of castor semilooper, *Achaea* Lin. *Indian J. Entomol.*, 66 (4): 301-307.

Srinivasa Rao, M. 2003. Crop pest weather relatio castor. In the Proc. of National Seminar on management for attaining self reliance in vege oils, Jan 28-30, 2003, Directorate on Oilse Research, Hyderabad, pp 115-116.

Tetens, O. 1930. Uber einige meteorologische Be *Z. Geophis.*, 6: 297-309.

Victor, U. S., Das, N. D., Srinivasa Rao, Vijayakumar, P. Srivastava, N.N., Vittal, K and Ramana Rao, B.V. 2003. Risk managem options using weather forecasts in insect pests a diseases management for some dryland crops *Agrometeorol.*, 5(1): 12-24.